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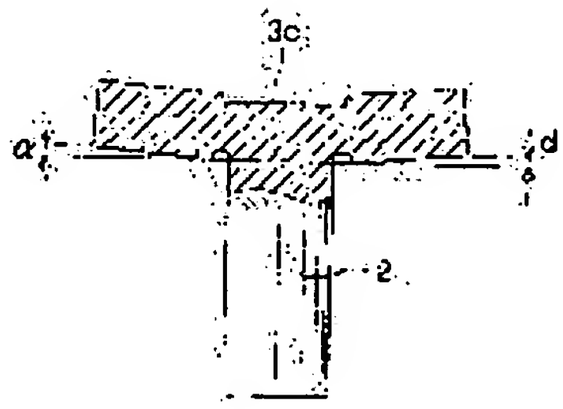
(54) METHOD FOR MANUFACTURING DYNAMIC PRESSURE GENERATING GROOVE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method for manufacturing a dynamic pressure generating groove for providing a dynamic pressure bearing to set a gap between a shaft member as an integrated body of a shaft with a flange part and an inner circumferential surface of a sleeve in a desired state after formation of the dynamic pressure generating groove even when there is residual internal stress in a case where drawn material is used.

SOLUTION: The dynamic generating groove is formed by plastic work in the surface of a flange part of the dynamic pressure bearing composed of the shaft member 1 comprising a shaft part 2 and a flange part 3, and a sleeve having a gap to the shaft part 2 and the flange part 3 for the shaft member 1 to be engaged. The shaft member 1 is formed by lathing of drawn material of which drawn direction is known. The shaft member is taken correctly as sized, the dynamic pressure generating groove is formed in the surface of the flange part, perpendicular distance from an outer circumferential end part of the flange part to the shaft part is measured, an obtained value is fed back to take the shaft member from the drawn



material, and plastic work is performed to the flange part.

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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]
the manufacture approach of the slot for dynamic pressure generating which forms the slot for dynamic pressure generating in the front face of the sleeve which prepares a clearance between the shank material in which the shank and the flange were formed, and these shanks and a flange, and inserted this shank material in it, and said flange of the hydrodynamic bearing come out of and constituted by plastic working -- setting
The manufacture approach of the slot for dynamic pressure generating characterized by to form the slot for dynamic pressure generating on the surface of a flange, to measure distance with the direction of a right angle over the shank of the periphery edge of this flange, to feed back this measured value next, to take [to face forming said shank material by the cutting process by turning from the drawing material the direction of drawing is proved that it is to take out the shank material as a dimension first,] out shank material from drawing material, and to perform plastic working to a flange.
[Claim 2]
Said flange is the manufacture approach of the slot for dynamic pressure generating according to claim 1 formed so that it may apply to the outer-diameter section from the bore section and thickness may become thin.
[Claim 3]
Said flange is the manufacture approach of the slot for dynamic pressure generating according to claim 1 formed so that it may apply to the outer-diameter section from the bore section and thickness may become thick.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
In the sleeve which prepared few clearances between the shank material by which this invention formed the flange in the shaft in one, and these shanks and a flange, and the hydrodynamic bearing which changes more It is related with the manufacture approach of the slot for dynamic pressure generating at the time of forming the slot for dynamic pressure generating in said flange front face by plastic working, and the manufacture approach of the slot for dynamic pressure generating which can make almost uniform especially the clearance between the flange of shank material using drawing material, and a sleeve axial side.
[0002]
[Description of the Prior Art]
After carrying out the cutting process by turning of the shank material which really formed the shank used as a hydrodynamic bearing, and the flange, it may carry out plastic working of the slot for dynamic pressure generating formed in a flange front face with a press etc., and may form it. For example, although a hydrodynamic bearing may be used for a spindle motor, the hydrodynamic bearing of the front face of the disc-like bearing member formed in a revolving shaft in this case is manufactured by press working of sheet metal (patent reference 1). Moreover, when processing the slot for dynamic pressure generating by plastic deformation, such as press working of sheet metal, the manufacture approach of preventing forming the perimeter of the inside of a flange low one step from an outside, forming the slot for dynamic pressure generating in the perimeter of an outside, and the perimeter of the inside rising at the time of processing is also proposed (patent reference 2).
[0003]
[Patent reference 1] JP,6-338125,A
[Patent reference 2] JP,8-210345,A
[0004]
[Problem(s) to be Solved by the Invention]
The processing approach which forms the slot for dynamic pressure generating by plastic working, such as press working of sheet metal, is difficult for forming the same configuration in the vertical side of a flange stably by hard material, such as stainless steel, to elasticity material, such as a copper alloy, although it is effective. It is difficult to perform plastic working to cold drawing work timber, and especially to form the slot for dynamic pressure generating stably.
That is, there was a phenomenon in which the suitable dynamic pressure for the hydrodynamic bearing formed with these shanks material 1 and a sleeve was no longer obtained even if it performs plastic working, such as press working of sheet metal, to the front faces 3a and 3b of the flange 3 of the shank material 1 which consists of the shank 2 taken out from cold drawing work timber (it only considers as drawing material hereafter) and a flange 3 and forms the slot for dynamic pressure generating in them, as shown in drawing 8 . Since residual stress exists in drawing material, even if it carries out press

working of sheet metal (plastic working) of that cause after a cutting process by turning as a design (drawing 9), after forming the dynamic pressure generating slot 4, a flange 3 deforms (referring to drawing 10 and deformation of this hard flow may also occur), and it is thought that it is the cause that the thing the clearance 5 between sleeves 6 stops being in the exact condition as a design (refer to drawing 11) is big. In addition, when residual stress exists, in order to remove this, the approach by annealing is also considered. However, according to annealing, an ingredient becomes soft too much and formation of the slot for dynamic pressure generating by plastic working like press working of sheet metal is impossible. Moreover, it is complicated to process the slot for dynamic pressure generating into sleeve inner skin, a thrust plate, etc., and it is difficult for cost to start and to form the stably same slot.
[0005]
It is made in order to cope with the technical problem described above, and residual stress exists in the interior using drawing material, and this invention aims at offering the manufacture approach of the slot for dynamic-pressure generating that the hydrodynamic bearing which will be in a condition as the clearance between the shank material and the sleeve inner skin which made the shank and the flange one also after plastic working for forming the slot for dynamic-pressure generating meant can be obtained.
[0006]
[Means for Solving the Problem]
namely, the manufacture approach of the slot for dynamic pressure generating which forms the slot for dynamic pressure generating in the front face of said flange of the sleeve which prepares a clearance between the shank material in which invention according to claim 1 formed the shank and the flange, and these shanks and a flange, and inserted this shank material in it, and the hydrodynamic bearing which it comes out and consists of by plastic working in order that this invention may offer the technical problem described above -- setting
The slot for dynamic pressure generating is formed on the surface of a flange, distance with the direction of a right angle over the shank of the periphery edge of this flange is measured, next this measured value is fed back, shank material is taken [it faces forming said shank material by the cutting process by turning from the drawing material the direction of drawing is proved that it is, and the shank material as a dimension is taken out first,] out from drawing material, and it is characterized by performing plastic working to a flange.
[0007]
Moreover, invention according to claim 2 is characterized by forming said flange so that it may apply to the outer-diameter section from the bore section and thickness may become thin.
[0008]
Moreover, invention according to claim 3 is characterized by forming said flange so that it may apply to the outer-diameter section from the bore section and thickness may become thick.
[0009]
[Embodiment of the Invention]
Hereafter, the gestalt of concrete operation of this invention is explained with reference to a drawing.
Drawing 1 shows the drawing material before facing enforcing the manufacture approach of the slot for dynamic pressure generating of the gestalt operation of the 1st of this invention (it considers as a dynamic pressure slot hereafter) and taking out shank material. In this case, the drawing material W draws out a material through a dice (tool) with the hole which made the point thin, decreases that cross section, and is manufactured. With the gestalt of this operation, a cutting process by turning is performed for this drawing material W, and the shank material 1 of T typeface is taken out. although this shank material 1 consists of a shank 2 and a flange 3 -- both sides of this flange 3 -- a herringbone form, V typeface, or a part -- the dynamic pressure slot on the screw type is formed by press working of sheet metal (plastic working).
[0010]
It faces forming a dynamic pressure slot in the flange 3 of said shank material 1. As shown in drawing 1 , on the front face of the drawing material W First, the striping X and X with a large number fine as a standard and ..., Vertical lines Y and Y and ... are put in and these striping X and X, .. and vertical lines

Y and Y, and the shank material 1 same with having carried out the cutting process by turning of a shank 2 or the flange 3 in parallel along with .., and having been shown in drawing 8 are formed. Once carrying out a cutting process by turning and taking out and carrying out press working of sheet metal (plastic working) of the shank material 1 so that such X, .., Y, and .. may be mentioned later, as shown in drawing 10 The direction of a right angle and the difference d of the height in a periphery edge (difference of the location of edges [in a flange 3 / main side edge section 3c / of bottom side 3b / and 3d of periphery edges] shaft orientations) are measured to whenever [tilt-angle / of a ** flange / alpha], or, a shaft 2. It considers as the standard for feeding back the numeric value, carrying out after [a cutting process by turning] press working of sheet metal anew, and taking out the exact shank material 1.

[0011]

Next, the shank material 1 in the condition of having formed the dynamic pressure slots 4 and 4 in both sides of a flange 3 by press working of sheet metal as shown in drawing 9 is manufactured. In this case, since residual stress has produced said shank material 1 in the drawing material W of the original ingredient, as it does not become a dimension as engineering drawing shown in original drawing 8 but is shown in drawing 10 , a flange 3 will be in a certain amount of condition of having carried out the include-angle (alpha) inclination, a little. Therefore, if it turns out that press working of sheet metal is carried out, and a flange 3 does alpha inclination in this way when forming a dynamic pressure slot beforehand As alpha is fed back whenever [this tilt-angle] and it is shown in drawing 2 , when taking out the shank material 1 of T typeface in drawing 1 , If a cutting process by turning is carried out to hard flow and press working of sheet metal is carried out to it in this condition of having inclined by the include angle (alpha), the flange 3 after processing can be made into the shank material 1 of an exact condition as shown in drawing 3 (A). Therefore, as shown in drawing 3 (B), the clearance 5 between the flanges 3 and the sleeves 6 in which the dynamic pressure slot 4 was formed on the front face turns into a proper clearance.

[0012]

Whenever [tilt-angle / of a flange 3], alpha is a minute include angle, when an exact include angle cannot be measured, may measure the direction of a right angle, and the difference d of the height in a periphery edge (difference of the location of edges [in a flange 3 / main side edge section 3c of bottom side 3b and 3d of periphery edges] shaft orientations) to a shaft 2, and may usually feed back the numeric value, so that it may describe above.

[0013]

In addition, in forming the exact shank material 1, classes (for example, stainless steel, carbon steel, etc.), the original direction of drawing, an original material manufacturer, etc. of a material of the drawing material W must be clear. It is because exact processing cannot be performed if it covers, the lathe-turning direction at the time of the condition (magnitude and direction) cutting process by turning of the residual stress of the interior after drawing out will not be known, but the deformation condition after press working of sheet metal will be investigated each time, if such material information is not clear, and a cutting process by turning and press working of sheet metal are not repeated.

[0014]

Next, the case where an inclination is established in the vertical side of the flange 3 formed in the shank material 1 is explained. First, the shank material 1 is taken out from the drawing material W by the cutting process by turning, and the case (gestalt of the 2nd operation) where it forms so that it may apply to the outer-diameter section (periphery edge) from the bore section of a flange 3 and thickness may become thin is explained.

When forming so that the shank material 1 may be taken out from the drawing material W by the cutting process by turning, it may apply to the outer-diameter section (periphery edge) from the bore section of a flange 3 and thickness may become thin, To the shaft 2 of the upper and lower sides of top side 3a of said shank material 1, the thick section of bottom side 3b, and an up-and-down periphery edge, as shown in drawing 4 (A), the difference of each height to the direction of a right angle It is h1 as (h, h) design as planned [original] do not become since residual stress has arisen inside this shank material 1, if press

working of sheet metal is carried out as h and h, but shown in drawing 4 (B). h2 And h1 <h2 It becomes. That is, since the distribution conditions of internal residual stress differ, top side 3a and bottom side 3b do not become the same.

[0015]

Next, it is [as opposed to / as shown in drawing 5 (A), when taking out the shank material 1 from the drawing material W by the cutting process by turning / the shaft 2 of the upper and lower sides of top side 3a, the thick section of bottom side 3b, and each flange 3 of a periphery edge] the difference of the height to the direction of a right angle h1 h2 It carries out and is h1. > h2 It is made to become. And if the dynamic pressure slots 4 and 4 are formed by press working of sheet metal in this condition, as shown in drawing 5 (B), the difference of the height to the direction of a right angle over the shaft 2 of each upper and lower sides of top side 3a of the flange 3 after forming the dynamic pressure slots 4 and 4, the thick section of bottom side 3b, and a periphery edge will be set to the almost same h and h.

[0016]

The difference of height [as opposed to / carry out plastic working like press working of sheet metal so that it may describe above, and / the direction of a right angle to the shaft 2 of the edge of the vertical sides 3a and 3b of a flange 3] is h1. h2 And h1 <h2 If it turns out that it becomes In drawing 1 , when taking out the shank material 1 of T typeface, the difference (h1 , h2) of these height is fed back, and as shown in drawing 5 (A), the cutting process by turning of the difference of height is beforehand established and carried out to hard flow. namely, the time of carrying out the cutting process by turning of the shank material 1, and taking it out -- each height of top side 3a, the thick section of bottom side 3b, and a periphery edge -- h1 h2 ** -- carrying out -- h1 [and] >h2 Then As shown in drawing 5 (B), the shank material 1 from which the difference of the height to the direction of a right angle is set to about h h to each shaft 2 of the thick section of vertical side 3a of the flange 3 after press working of sheet metal and 3b ** and a periphery edge can be obtained.

[0017]

Next, it is the case where an inclination is established in the flange 3 formed in the shaft side material 1, and the vertical sides 3a and 3b of a flange 3 explain the case (gestalt of the 3rd operation) where it forms so that it may apply to the outer-diameter section (periphery edge) from the bore section and thickness may become thick.

When forming so that the shank material 1 may be taken out from the drawing material W by the cutting process by turning, it may apply to the outer-diameter section (periphery edge) from the bore section of a flange 3 and thickness may become thick, If press working of sheet metal of the difference is carried out as j and j as shown in drawing 6 (A), since residual stress has produced each height of top side 3a of said shank material 1, the thick section of bottom side 3b, and a periphery edge inside this shank material 1, For (j, j) design as planned [original], also in this case, the difference of the height to the direction of a right angle is [as opposed to / a little / as it does not become but is shown in drawing 6 (B) / the shaft 2 of the upper and lower sides of a flange 3] j1. j2 And j1 <j2 It becomes. That is, since the distribution conditions of residual stress differ, a top side and a bottom side do not become the same.

[0018]

Next, it is [as opposed to / when taking out the shank material 1 from the drawing material W by the cutting process by turning / the shaft 2 of the upper and lower sides of top side 3a, the thick section of bottom side 3b, and each flange 3 of a periphery edge] the difference of the height to the direction of a right angle j1 j2 It carries out and is j1. > j2 It is made to become. And if the dynamic pressure slots 4 and 4 are formed by press working of sheet metal in this condition, as shown in drawing 7 (B), the difference of the height to the direction of a right angle over the shaft 2 of each upper and lower sides of top side 3a of the flange 3 after forming the dynamic pressure slots 4 and 4, the thick section of bottom side 3b, and a periphery edge will be set to the almost same j and j.

[0019]

Therefore, the difference of height [as opposed to / carry out plastic working also in this case, and / the direction of a right angle to the shaft 2 of the edge of the vertical sides 3a and 3b of a flange 3] is j1. j2

If it turns out that it becomes What is necessary is to feed back the difference (j1 , j2) of these height, and just to prepare the difference of height in hard flow beforehand in drawing 1 , as shown in drawing 7 (A) when taking out the shank material 1 of T typeface. That is, when carrying out the cutting process by turning of the shank material 1 and taking it out, each height of top side 3a, the thick section of bottom side 3b, and a periphery edge is j1. j2 ** and j1 > j2 If it carries out As shown in drawing 7 (B), the shank material 1 from which the difference of the height to the direction of a right angle is set to about j j to each shaft 2 of the thick section of vertical side 3a of the flange 3 after press working of sheet metal and 3b ** and a periphery edge can be obtained.

[0020]

In the gestalt of operation of this invention, although the case where the shank material 1 was T typeface was explained, of course, you may be the shank material in which the flange 3 was formed to the perimeter in the middle of a shank 2. Moreover, also when only the top-face 3a of a flange 3 establishes an inclination only in inferior-surface-of-tongue 3b or it forms the slot 4 for dynamic pressure generating, it can apply. Furthermore, although crevice 3c is formed in the top-most-vertices center section of the T typeface in the shank material 1 of T typeface as shown in drawing, this top-most-vertices center section may be in a flat-tapped level flat-surface condition.

[0021]

Especially the table 1 is set in the gestalt of the 3rd operation in the manufacture approach of the slot for dynamic pressure generating on this invention. For each height of top side 3a of the shank material 1, the thick section of bottom side 3b, and a periphery edge, as the shank material 1 which consists of a shank 2 and a flange 3 by the cutting process by turning is actually taken out from the drawing material W (stainless steel material) and it is shown in drawing 6 (A), a difference It is j1 before press working of sheet metal. j2 It is the table showing the result of having manufactured the value 3 times, respectively and having measured the value after press working of sheet metal.

[Table 1]

	j_1 (mm)			j_2 (mm)		
プレス前	1回目 0.017	2回目 0.014	3回目 0.017	1回目 0.017	2回目 0.014	3回目 0.017
プレス後	0.001～0.002			0.001～0.002		

For the shank material 1 taken out from drawing material by the cutting process by turning as shown in this table 1, if it feeds back and a flange 3 is formed in consideration of the effect of that residual stress, a shank 2 and a flange 3 will be. It became clear that it could consider as the shank material 1 which has almost exact squareness.

[0022]

[Effect of the Invention]

As mentioned above, as explained in full detail, when using drawing material, such as stainless steel and carbon steel, according to the manufacture approach of the slot for dynamic pressure generating on this invention, an exact hydrodynamic bearing as the clearance between the shank material and sleeve inner skin which made one a shaft and a flange after residual stress's existing in the interior and processing the slot for dynamic pressure generating by plastic working like press working of sheet metal meant can be obtained. Moreover, according to the manufacture approach of this invention, complicated processing of the slot for dynamic pressure generating becomes unnecessary at a sleeve, a thrust plate, etc.

Furthermore, since the slot for dynamic pressure generating same to coincidence as vertical both sides of a flange established in the shaft is processible, a routing counter can be reduced. Moreover, since the slot for dynamic pressure generating of the same configuration is stably obtained when processing the slot for dynamic pressure generating on vertical both sides of a flange established in the shaft, the precision after assembly completion can become good, a defective incidence rate can also fall, and the part manufacturing cost can be reduced.

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing cold drawing work timber before facing enforcing the manufacture approach of the slot for dynamic pressure generating on this invention and taking out shank material.

[Drawing 2] When taking out the shank material of T typeface, it is drawing showing the shank material which carried out the cutting process by turning in the distorted condition produced to hard flow in consideration of the result which carried out press working of sheet metal beforehand of having inclined by the include angle.

[Drawing 3] Drawing 3 (A) is drawing showing the shank material in the condition of having carried out press working of sheet metal of the shank material which carried out the cutting process by turning in the distorted condition produced to hard flow in consideration of the result which carried out press working of sheet metal beforehand of having inclined by the include angle, and drawing 3 (B) is a sectional view in the condition of inserting this shank material in the sleeve.

[Drawing 4] it is the case where it forms so that it may apply to the outer-diameter section (periphery edge) from the bore section of the flange of the shank material taken out from drawing material and thickness may become thin, and drawing 4 (A) shows the condition before press working of sheet metal -- it is a sectional view a part and drawing 4 (B) shows the condition after ** pass processing -- it is a sectional view a part.

[Drawing 5] it is the case where it forms so that it may apply to the outer-diameter section (periphery edge) from the bore section of the flange of the shank material taken out from drawing material and thickness may become thin, and drawing 5 (A) shows the condition before press working of sheet metal -- it is a sectional view a part and drawing 5 (B) shows the condition after press working of sheet metal -- it is a sectional view a part.

[Drawing 6] it is the case where it forms so that it may apply to the outer-diameter section (periphery edge) from the bore section of the flange of the shank material taken out from drawing material and thickness may become thick, and drawing 6 (A) shows the condition before press working of sheet metal -- it is a sectional view a part and drawing 6 (B) shows the condition after ** pass processing -- it is a sectional view a part.

[Drawing 7] it is the case where it forms so that it may apply to the outer-diameter section (periphery edge) from the bore section of the flange of the shank material taken out from drawing material and thickness may become thick, and drawing 7 (A) shows the condition before press working of sheet metal -- it is a sectional view a part and drawing 7 (B) shows the condition after press working of sheet metal -

- it is a sectional view a part.
[Drawing 8] It is drawing showing the shank material of T typeface which consists of a shank taken out from cold drawing work timber by the cutting process by turning, and a flange.
[Drawing 9] It is drawing showing the condition for forming the slot for dynamic pressure generating in the flange of the shank material taken out from cold drawing work timber by the cutting process by turning of carrying out press working of sheet metal.
[Drawing 10] In order to form the slot for dynamic pressure generating in the flange of the shank material taken out from cold drawing work timber by the cutting process by turning, it is drawing showing the condition of having carried out press working of sheet metal.
[Drawing 11] After forming the slot for dynamic pressure generating in the flange of the shank material taken out from cold drawing work timber by the cutting process by turning, it is drawing showing the sectional view of the hydrodynamic bearing in the condition of inserting this shank material in the sleeve.
[Description of Notations]
1 Shank Material
2 Shank
3 Flange
4 Slot for Dynamic Pressure Generating

[Translation done.]

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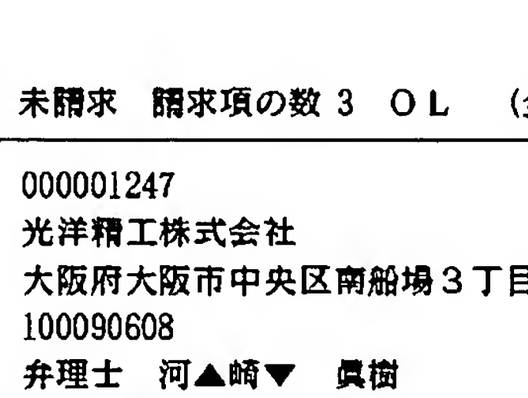
最終頁に続く

(54)【発明の名称】動圧発生用溝の製造方法

(57)【要約】
【課題】引き抜き材を使用し内部に残留応力があっても、動圧発生用溝の加工後の軸とフランジ部とを一体とした軸部材とスリーブ内周面との間の隙間が意図したとおりの状態となる動圧軸受を得ることのできる動圧発生用溝の製造方法を提供する。
【解決手段】軸部２とフランジ部３とを形成した軸部材１と、これら軸部２フランジ部３との間に隙間を設けて該軸部材１を嵌め入れたスリーブと、で構成される動圧軸受の前記フランジ部の表面に動圧発生用溝を塑性加工により形成する場合、引き抜き方向の判明している引き抜き材から旋削加工により前記軸部材１を形成するに際し、先ず寸法通りの軸部材を取り出し、フランジ部の表面に動圧発生用溝を形成して該フランジ部の外周端部の軸部に対する直角方向との距離を測定し、この測定値をフィードバックして引き抜き材から軸部材を取り出し、フランジ部に塑性加工を施す。
【選択図】　図２



【特許請求の範囲】
【請求項1】
軸部とフランジ部とを形成した軸部材と、これら軸部とフランジ部との間に隙間を設けて該軸部材を嵌め入れたスリーブと、で構成される動圧軸受の前記フランジ部の表面に動圧発生用溝を塑性加工により形成する動圧発生用溝の製造方法において、
引き抜き方向の判明している引き抜き材から旋削加工により前記軸部材を形成するに際し、先ず寸法通りの軸部材を取り出し、フランジ部の表面に動圧発生用溝を形成して該フランジ部の外周端部の軸部に対する直角方向との距離を測定し、次にこの測定値をフィードバックして引き抜き材から軸部材を取り出し、フランジ部に塑性加工を施すことを特徴とする動圧発生用溝の製造方法。
【請求項2】
前記フランジ部は、内径部から外径部にかけて肉厚が薄くなるように形成したものである請求項１に記載の動圧発生用溝の製造方法。
【請求項3】
前記フランジ部は、内径部から外径部にかけて肉厚が厚くなるように形成したものである請求項１に記載の動圧発生用溝の製造方法。

【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明は、軸にフランジ部を一体的に形成した軸部材と、これら軸部とフランジ部との間に僅かな隙間を設けたスリーブと、より成る動圧軸受において、前記フランジ表面に塑性加工により動圧発生用溝を形成する際の動圧発生用溝の製造方法、特に、引き抜き材を用いた軸部材のフランジ部とスリーブアキシャル面との間の隙間を殆ど均一とすることのできる動圧発生用溝の製造方法に関する。
【０００２】
【従来の技術】
動圧軸受として使用される軸部とフランジ部とを一体形成した軸部材は、旋削加工した後、フランジ部表面に形成する動圧発生用溝をプレス等により塑性加工して形成する場合がある。例えば、スピンドルモータには、動圧軸受が使用されることがあるが、この場合、回転軸に形成する円盤状軸受部材の表面の動圧軸受は、プレス加工によって製作される（特許文献１）。また、プレス加工等の塑性変形で動圧発生用溝を加工するとき、フランジ部の内側周囲を外側より一段低く形成し、外側周囲に動圧発生用溝を形成して加工時内側周囲が盛り上がるのを防止する製造方法も提案されている（特許文献２）。
【０００３】
【特許文献１】特開平６－３３８１２５
【特許文献２】特開平８－２１０３４５
【０００４】
【発明が解決しようとする課題】
プレス加工等の塑性加工で動圧発生用溝を形成する加工方法は、銅合金等の軟質材に対しては有効であるが、ステンレス鋼等のような硬質材でフランジ部の上下面に同一形状を安定的に形成するのは困難である。特に、冷間引き抜き加工材に塑性加工を施して安定的に動圧発生用溝を形成するのは難しい。
即ち、図８に示すように、冷間引き抜き加工材（以下、単に引き抜き材とする）から取り出した軸部２とフランジ部３とより成る軸部材１のフランジ部３の表面３ａ，３ｂにプレス加工等の塑性加工を施して動圧発生用溝を形成しても、これら軸部材１とスリーブとで形成された動圧軸受に適切な動圧が得られなくなるという現象があった。その原因は、引き抜き材に残留応力が存在しているため、旋削加工後に設計どおりプレス加工（塑性加工）しても（図９）、動圧発生溝４を形成した後フランジ部３が変形し（図１０参照、この逆方向の変形もあり得る）、スリーブ６との間の隙間５が設計どおりの正確な状態でなくなる（図１１参照）ことが大きな原因であると考えられる。尚、残留応力が存在する場合

、これを除去するため焼鈍による方法も考えられる。しかし、焼鈍によると、材料が柔らかくなりすぎてプレス加工のような塑性加工による動圧発生用溝の形成は不可能である。また、スリーブ内周面やスラスト板等に動圧発生用溝を加工するのは煩雑でコストがかかり、安定的に同一の溝を形成するのは難しい。

【０００５】

この発明は、上記する課題に対処するためになされたものであり、引き抜き材を使用し内部に残留応力が存在し、動圧発生用溝を形成するための塑性加工後でも軸部とフランジ部とを一体とした軸部材とスリーブ内周面との間の隙間が意図したとおりの状態となる動圧軸受を得ることのできる動圧発生用溝の製造方法を提供することを目的としている。

【０００６】

【課題を解決するための手段】

即ち、この発明は上記する課題を提供するために、請求項１に記載の発明は、軸部とフランジ部とを形成した軸部材と、これら軸部とフランジ部との間に隙間を設けて該軸部材を嵌め入れたスリーブと、で構成される動圧軸受の前記フランジ部の表面に動圧発生用溝を塑性加工により形成する動圧発生用溝の製造方法において、

引き抜き方向の判明している引き抜き材から旋削加工により前記軸部材を形成するに際し、先ず寸法通りの軸部材を取り出し、フランジ部の表面に動圧発生用溝を形成して該フランジ部の外周端部の軸部に対する直角方向との距離を測定し、次にこの測定値をフィードバックして引き抜き材から軸部材を取り出し、フランジ部に塑性加工を施すことを特徴とするものである。

【０００７】

また、請求項２に記載の発明は、前記フランジ部は、内径部から外径部にかけて肉厚が薄くなるように形成したものであることを特徴とするものである。

【０００８】

また、請求項３に記載の発明は、前記フランジ部は、内径部から外径部にかけて肉厚が厚くなるように形成したものであることを特徴とするものである。

【０００９】

【発明の実施の形態】

以下、本発明の具体的な実施の形態について図面を参照して説明する。

図１は、本発明の第１の実施の形態の動圧発生用溝（以下、動圧溝とする）の製造方法を実施するに際して軸部材を取り出す前の引き抜き材を示す。この場合、引き抜き材Ｗは、先を細くした穴をもつダイス（工具）を通して素材を引き抜き、その断面積を減少させて製作したものである。この実施の形態では該引き抜き材Ｗを旋削加工を施して、Ｔ字形の軸部材１を取り出す。この軸部材１は、軸部２とフランジ部３とよりなるが、該フランジ部３の両面に、ヘリングボーン形やＶ字形或いは一部螺旋形の動圧溝をプレス加工（塑性加工）により形成する。

【００１０】

前記軸部材１のフランジ部３に動圧溝を形成するに際しては、先ず、図１に示すように、引き抜き材Ｗの表面に、目安として多数の細かい横線Ｘ，Ｘ，・・・と、縦線Ｙ，Ｙ，・・・を入れておき、これらの横線Ｘ，Ｘ，・・や縦線Ｙ，Ｙ，・・に沿って平行に軸部２やフランジ部３を旋削加工して図８に示したのと同様の軸部材１を形成する。これらのＸ，・・、Ｙ，・・は、後述するように、一旦、旋削加工して軸部材１を取り出しプレス加工（塑性加工）した後、図１０に示すように、のフランジ部の傾斜角度α或いは、軸２に対して直角方向と外周端部における高さの差ｄ（フランジ部３における下側面３ｂの中心側端部３ｃと外周端部３ｄとの軸方向の位置の差）を測定し、その数値をフィードバックして改めて旋削加工後プレス加工して正確な軸部材１を取り出すための目安とする。

【００１１】

次に、フランジ部３の両面に図９に示すように、プレス加工により動圧溝４，，４を形成した状態の軸部材１を製作する。この場合、前記軸部材１は、元の材料の引き抜き材Ｗ内に残留応力が生じているため、当初の図８に示す設計図通りの寸法とはならず、図１０に

示すように、若干フランジ部３はある程度の角度（α）傾斜した状態となる。従って、予め動圧溝を形成する場合、プレス加工してこのようにフランジ部３がα傾斜することが判っていれば、この傾斜角度αをフィードバックして、図２に示すように、図１においてＴ字形の軸部材１を取り出すとき、逆方向にこの角度（α）分傾斜した状態で旋削加工してプレス加工すれば、加工後のフランジ部３は、図３（Ａ）に示すように、正確な状態の軸部材１とすることができる。従って、図３（Ｂ）に示すように、その表面に動圧溝４を形成したフランジ部３とスリーブ６との間の隙間５は、適正な隙間となる。

【００１２】

上記するように、フランジ部３の傾斜角度αは、通常、微小な角度であり、正確な角度が測定できない場合は、軸２に対して直角方向と外周端部における高さの差ｄ（フランジ部３における下側面３ｂの中心側端部３ｃと外周端部３ｄとの軸方向の位置の差）を測定し、その数値をフィードバックしても良い。

【００１３】

尚、正確な軸部材１を形成するにあたっては、元の引き抜き材Ｗの素材の種類（例えば、ステンレス鋼、炭素鋼等）、引き抜き方向及び素材メーカー等が明確になっていなければならない。蓋し、そのような素材情報が明確でないと、引き抜き後の内部の残留応力の状態（大きさや方向）旋削加工時の旋削方向が判らず、その都度、プレス加工後の変形状態を調査して旋削加工とプレス加工を繰り返さなければ正確な加工が出来ないからである。

【００１４】

次に、軸部材１に形成されるフランジ部３の上下面に傾斜を設ける場合について説明する。先ず、引き抜き材Ｗから旋削加工により軸部材１を取り出して、フランジ部３の内径部から外径部（外周端部）にかけて肉厚が薄くなるように形成する場合（第２の実施の形態）について説明する。

引き抜き材Ｗから旋削加工により軸部材１を取り出して、フランジ部３の内径部から外径部（外周端部）にかけて肉厚が薄くなるように形成する場合、前記軸部材１の上側面３ａと下側面３ｂの肉厚部と上下の外周端部の上下の軸２に対して直角方向に対するそれぞれの高さの差を、図４（Ａ）に示すように、ｈ，ｈとしてプレス加工すると、該軸部材１の内部には残留応力が生じているため、当初の設計予定通りの（ｈ，ｈ）とはならず、図４（Ｂ）に示すように、h_1　、h_2　で且つh_1　＜h_2　となる。即ち、上側面３ａと下側面３ｂとは内部の残留応力の分布状態が異なっているので同一とはならない。

【００１５】

次に、図５（Ａ）に示すように、引き抜き材Ｗから旋削加工により軸部材１を取り出すとき、上側面３ａと下側面３ｂの肉厚部と外周端部のそれぞれのフランジ部３の上下の軸２に対して直角方向に対する高さの差を、h_1　、h_2　とし且つh_1　＞h_2　となるようにする。そして、この状態でプレス加工により動圧溝４，４を形成すると、図５（Ｂ）に示すように、動圧溝４，４を形成した後のフランジ部３の上側面３ａと下側面３ｂの肉厚部と外周端部のそれぞれの上下の軸２に対する直角方向に対する高さの差は、ほぼ同じｈ、ｈとなる。

【００１６】

上記するように、プレス加工のような塑性加工をしてみてフランジ部３の上下面３ａ、３ｂの端部の軸２に対して直角方向に対する高さの差がh_1　、h_2　で且つh_1　＜h_2　となることが判れば、図１において、Ｔ字形の軸部材１を取り出すとき、これらの高さの差（h_1　，h_2　）をフィードバックして、図５（Ａ）に示すよう逆方向に、予め高さの差を設けて旋削加工する。即ち、軸部材１を旋削加工して取り出すとき、上側面３ａと下側面３ｂの肉厚部と外周端部のそれぞれの高さをh_1　，h_2　とし且つh_1　＞h_2　とすれば、図５（Ｂ）に示すように、プレス加工後のフランジ部３の上下面３ａ、３ｂのの肉厚部と外周端部のそれぞれの軸２に対して直角方向に対する高さの差がほぼｈ、ｈとなる軸部材１を得ることができる。

【００１７】

次に、軸側材１に形成されるフランジ部３に傾斜を設ける場合であって、フランジ部３の

上下面３ａ，３ｂは、内径部から外径部（外周端部）にかけて肉厚が厚くなるように形成する場合（第３の実施の形態）について説明する。
引き抜き材Ｗから旋削加工により軸部材１を取り出して、フランジ部３の内径部から外径部（外周端部）にかけて肉厚が厚くなるように形成する場合、前記軸部材１の上側面３ａと下側面３ｂの肉厚部と外周端部のそれぞれの高さを差を図６（Ａ）に示すように、ｊ，ｊとしてプレス加工すると、該軸部材１の内部には残留応力が生じているため、この場合も当初の設計予定通りの（ｊ，ｊ）とはならず、図６（Ｂ）に示すように、若干フランジ部３の上下の軸２に対して直角方向に対する高さの差は、j_1 ，j_2 で且つj_1 ＜j_2 となる。即ち、上側面と下側面とは残留応力の分布状態が異なっているので同一とはならない。

【００１８】

次に、引き抜き材Ｗから旋削加工により軸部材１を取り出すとき、上側面３ａと下側面３ｂの肉厚部と外周端部のそれぞれのフランジ部３の上下の軸２に対して直角方向に対する高さの差を、j_1 、j_2 とし且つj_1 ＞j_2 となるようにする。そして、この状態でプレス加工により動圧溝４，４を形成すると、図７（Ｂ）に示すように、動圧溝４，４を形成した後のフランジ部３の上側面３ａと下側面３ｂの肉厚部と外周端部のそれぞれの上下の軸２に対する直角方向に対する高さの差は、ほぼ同じｊ、ｊとなる。

【００１９】

従って、この場合も塑性加工してみてフランジ部３の上下面３ａ、３ｂの端部の軸２に対して直角方向に対する高さの差がj_1 ，j_2 となることが判れば、図１において、Ｔ字形の軸部材１を取り出すとき、これらの高さの差（j_1 ，j_2 ）をフィードバックして、図７（Ａ）に示すよう逆方向に、予め高さの差を設ければ良い。即ち、軸部材１を旋削加工して取り出すとき、上側面３ａと下側面３ｂの肉厚部と外周端部のそれぞれの高さがj_1 ，j_2 て且つj_1 ＞j_2 とすれば、図７（Ｂ）に示すように、プレス加工後のフランジ部３の上下面３ａ、３ｂのの肉厚部と外周端部のそれぞれの軸２に対して直角方向に対する高さの差がほぼｊ、ｊとなる軸部材１を得ることができる。

【００２０】

本発明の実施の形態においては、軸部材１がＴ字形の場合について説明したが、勿論、軸部２の途中の周囲にフランジ部３を形成した軸部材であっても良い。また、フランジ部３の上面３ａのみ或いは下面３ｂのみに傾斜を設けたり、動圧発生用溝４を形成する場合にも適用することができる。更に、Ｔ字形の軸部材１では、図に示すように、Ｔ字形の頂点中央部には、凹部３ｃを形成してあるが、この頂点中央部が面一の水平の平面状態であっても良い。

【００２１】

表１は、本発明の動圧発生用溝の製造方法において、特に、第３の実施の形態において、実際に引き抜き材Ｗ（ステンレス材）から旋削加工により軸部２とフランジ部３とより成る軸部材１を取り出し、軸部材１の上側面３ａと下側面３ｂの肉厚部と外周端部のそれぞれの高さを差を図６（Ａ）に示すように、プレス加工前にj_1 ，j_2 の値をそれぞれ３回製作し、プレス加工後の値を測定した結果を示す表である。

【表１】

	j ₁ （mm）			j ₂ （mm）		
プレス前	1回目	2回目	3回目	1回目	2回目	3回目
	0.017	0.014	0.017	0.017	0.014	0.017
プレス後	0.001～0.002			0.001～0.002		

この表１に示すように、引き抜き材から旋削加工により取り出した軸部材１は、その残留応力の影響を考慮して、フィードバックしてフランジ部３を形成すれば、軸部２とフランジ部３とが　ほぼ正確な直角度を有する軸部材１とすることができることが判明した。

【００２２】

【発明の効果】

以上、詳述したように、本発明の動圧発生用溝の製造方法によれば、ステンレス鋼や炭素鋼等の引き抜き材を使用する場合、内部に残留応力が存在してプレス加工のような塑性加工により動圧発生用溝を加工した後の軸とフランジ部とを一体とした軸部材とスリーブ内周面との間の隙間が意図したとおりの正確な動圧軸受を得ることができる。また、本発明の製造方法によれば、スリーブやスラスト板等に動圧発生用溝の煩雑な加工が不要となる。更に、軸に設けたフランジ部の上下両面に同時に同じ動圧発生用溝を加工することができるので工程数を低減することができる。また、軸に設けたフランジ部の上下両面に動圧発生用溝を加工する場合、同じ形状の動圧発生用溝が安定的に得られるので、組立完了後の精度が良くなり、不良品発生率も低下しその分製造コストを低減することができる。

【図面の簡単な説明】

【図１】本発明の動圧発生用溝の製造方法を実施するに際して軸部材を取り出す前の冷間引き抜き加工材を示す図である。

【図２】Ｔ字形の軸部材を取り出すとき、予めプレス加工した結果を考慮して逆方向に生じた歪の角度分傾斜した状態で旋削加工した軸部材を示す図である。

【図３】図３（Ａ）は、予めプレス加工した結果を考慮して逆方向に生じた歪の角度分傾斜した状態で旋削加工した軸部材をプレス加工した状態の軸部材を示す図であり、図３（Ｂ）は、この軸部材をスリーブに嵌め入れた状態の断面図である。

【図４】引き抜き材から取り出した軸部材のフランジ部の内径部から外径部（外周端部）にかけて肉厚が薄くなるように形成する場合であって、図４（Ａ）は、プレス加工前の状態を示す一部断面図であり、図４（Ｂ）は、付パス加工後の状態を示す一部断面図である。

【図５】引き抜き材から取り出した軸部材のフランジ部の内径部から外径部（外周端部）にかけて肉厚が薄くなるように形成する場合であって、図５（Ａ）は、プレス加工前の状態を示す一部断面図であり、図５（Ｂ）は、プレス加工後の状態を示す一部断面図である

【図６】引き抜き材から取り出した軸部材のフランジ部の内径部から外径部（外周端部）にかけて肉厚が厚くなるように形成する場合であって、図６（Ａ）は、プレス加工前の状態を示す一部断面図であり、図６（Ｂ）は、付パス加工後の状態を示す一部断面図である。

【図７】引き抜き材から取り出した軸部材のフランジ部の内径部から外径部（外周端部）にかけて肉厚が厚くなるように形成する場合であって、図７（Ａ）は、プレス加工前の状態を示す一部断面図であり、図７（Ｂ）は、プレス加工後の状態を示す一部断面図である。

【図８】冷間引き抜き加工材から旋削加工により取り出した軸部とフランジ部からなるＴ字形の軸部材を示す図である。

【図９】冷間引き抜き加工材から旋削加工により取り出した軸部材のフランジ部に動圧発生用溝を形成するためのプレス加工する状態を示す図である。

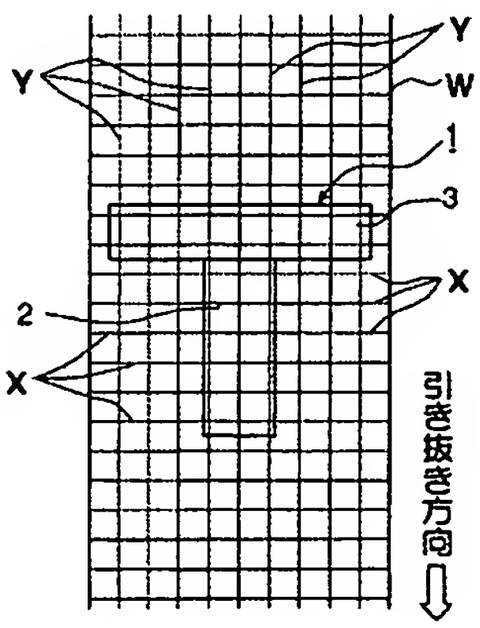
【図１０】冷間引き抜き加工材から旋削加工により取り出した軸部材のフランジ部に動圧発生用溝を形成するためプレス加工した状態を示す図である。

【図１１】冷間引き抜き加工材から旋削加工により取り出した軸部材のフランジ部に動圧発生用溝を形成した後この軸部材をスリーブに嵌め入れた状態の動圧軸受の断面図を示す図である。

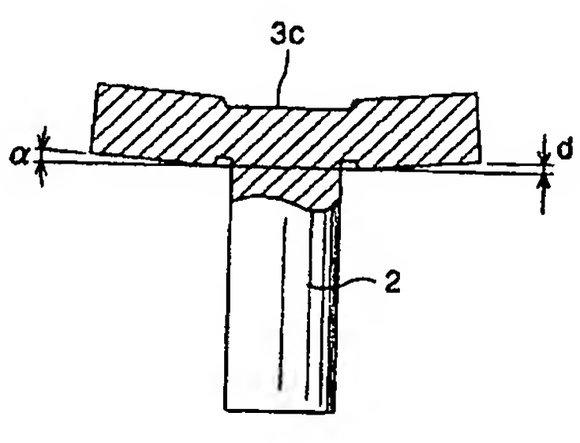
【符号の説明】

1　　軸部材
2　　軸部
3　　フランジ部
4　　動圧発生用溝

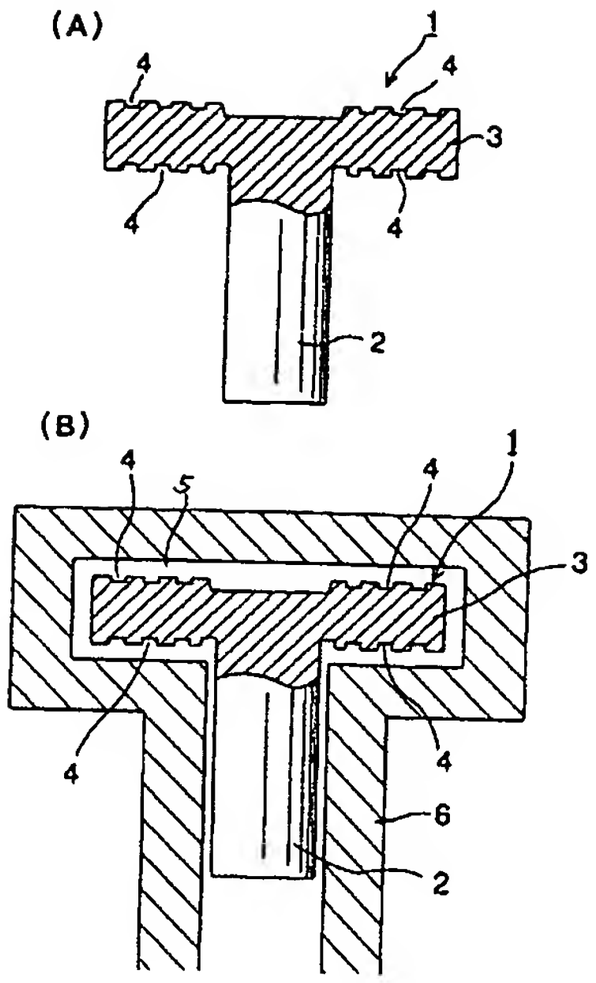
【図1】



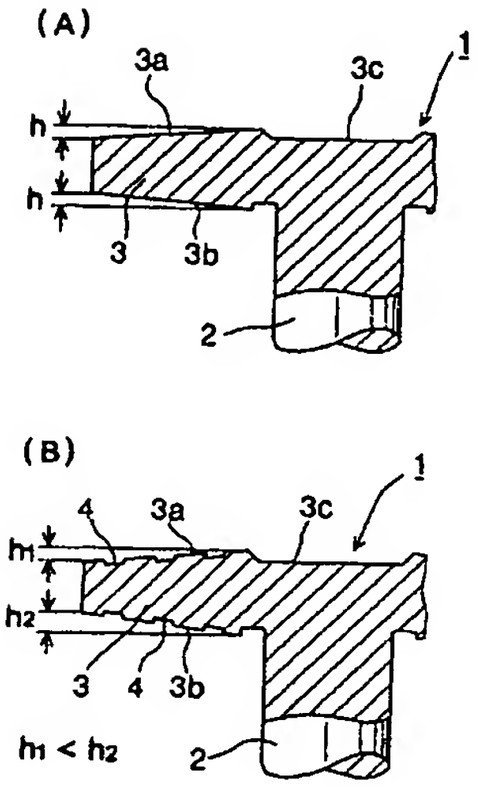
【図2】



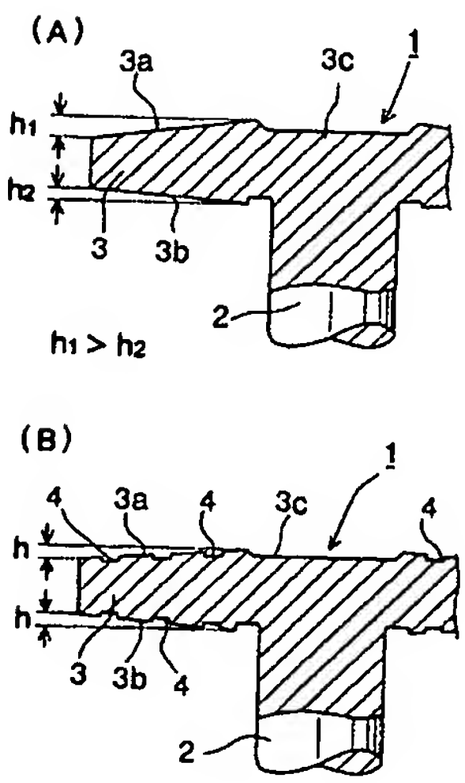
【図3】


(A)
1
4
4
3
4
4
2
(B)
4
5
4
1
3
4
4
6
2

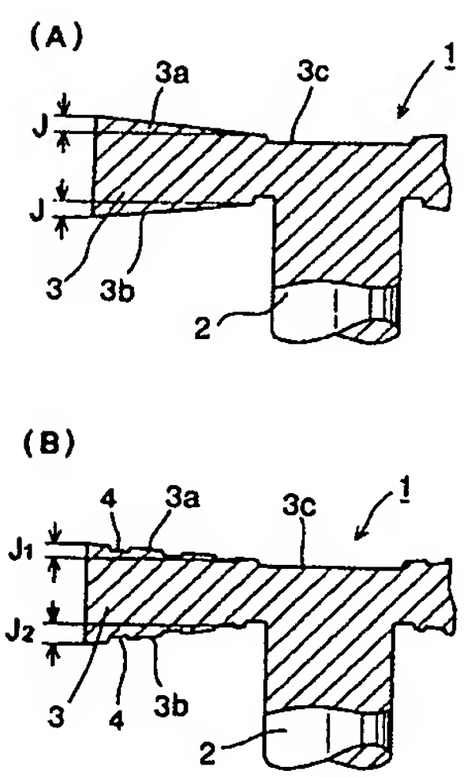
【図4】


(A)
3a
3c
1
h
h
3
3b
2
(B)
1
4
3a
3c
h1
h2
3
4
3b
h1 < h2
2

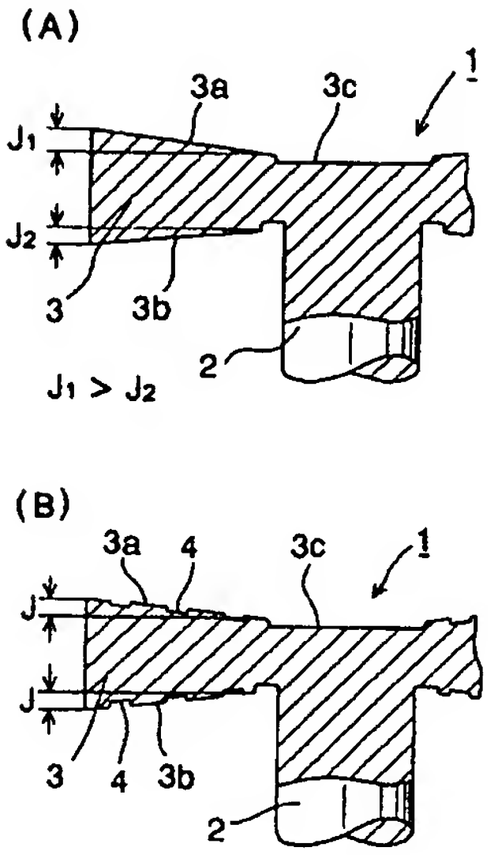
【図5】


(A)
3a
3c
1
h1
h2
3
3b
2
h1 > h2
(B)
1
4
3a
4
3c
4
h
h
3
3b
4
2

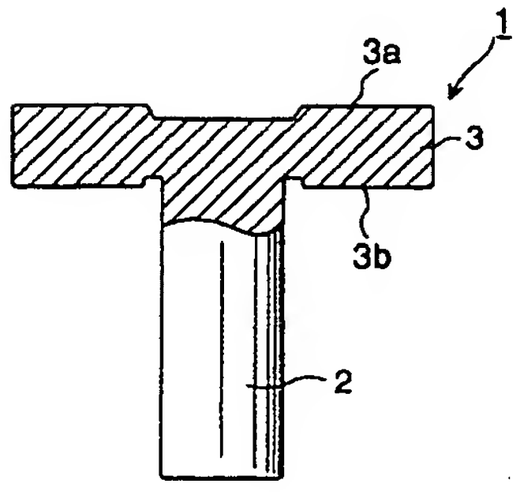
【図6】


(A)
3a
3c
1
J
J
3
3b
2
(B)
4
3a
3c
1
J1
J2
3
4
3b
2
J2 > J1

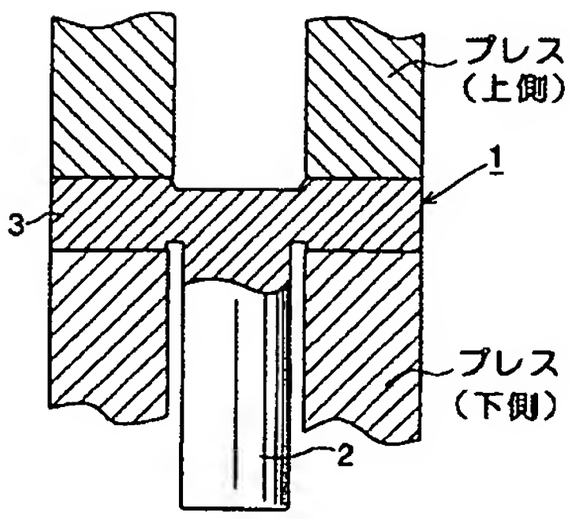
【図7】


(A)
3a
3c
1
J1
J2
3
3b
2
J1 > J2
(B)
3a
4
3c
1
J
J
3
4
3b
2

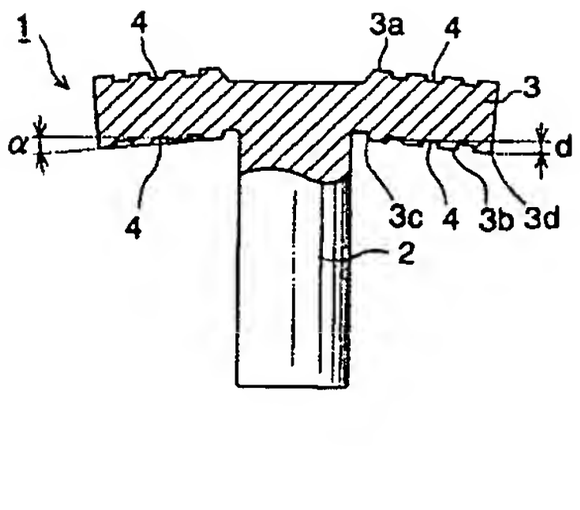
【図8】


1
3a
3
3b
2

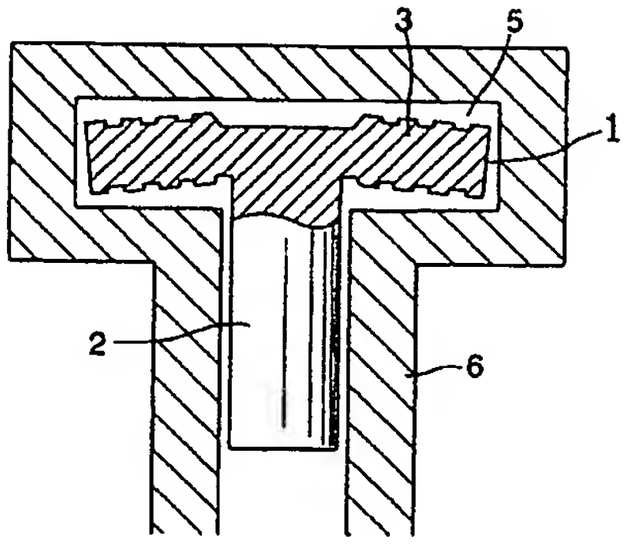
【図9】


プレス
(上側)
1
3
プレス
(下側)
2

【図10】


1
4
3a
4
3
α
d
4
3c
4
3b
3d
2

【図11】



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